

Abstract

Time-variable gravity from space:
Quarter century of observations, mysteries, and prospects

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Any large mass transport in the Earth system produces changes in the gravity field. Via the space geodetic technique of satellite-laser ranging in the last quarter century, the Earth's dynamic oblateness J_2 (the lowest-degree harmonic component of the gravity field) has been observed to undergo a slight decrease -- until around 1998, when it switched quite suddenly to an increase trend which has continued to 2001 before sharply turning back to the value which it is "supposed to be"!. The secular decrease in J_2 has long been attributed primarily to the post-glacial rebound in the mantle; the present increase signifies an even larger change in global mass distribution whose J_2 effect overshadows that of the post-glacial rebound, at least over interannual timescales. Intriguing evidences have been found in the ocean water distribution, especially in the extratropical Pacific basins, that may be responsible for this J_2 change. New techniques based on satellite-to-satellite tracking will yield greatly improved observations for time-variable gravity, with much higher precision and spatial resolution (i.e., much higher harmonic degrees). The most important example is the GRACE mission launched in March 2002, following the success of the CHAMP mission. Such observations are becoming a new and powerful tool for remote sensing of geophysical fluid processes that involve larger-scale mass transports.